

WHRP REQUEST FOR PROPOSAL

I. PROBLEM TITLE

Evaluation of the Foundation Movements of Transportation Structures

II. BACKGROUND AND PROBLEM STATEMENT

Transportation structures (bridges and retaining walls) in Wisconsin are typically supported on deep foundations such as piles or shallow foundations such as spread footings. WisDOT generally follows the AASHTO design code when designing these foundation systems. AASHTO now designs using Load and Resistance Factor Design (LRFD) methods. Designing for service requirements, such as vertical and/or horizontal movements, due to applied loads must now be investigated when designing with LRFD methodologies.

Past Departmental design methods generally assumed piles to have little/no vertical or horizontal movement. Spread footings were also assumed to have no lateral movement and little vertical movement. We know that both of these foundation systems experience some amount of movement in both directions. The actual movement of both types of foundation systems needs to be determined to help refine design assumptions used in LRFD.

Piles are also used to provide lateral load resistance to movement. In the past, typical values of pile resistance to lateral loads were assumed in design. These values were based on the type of pile and general soil conditions. Lateral pile load analyses led to the development of the software program, LPILE. This software is being used by many highway agencies to analyze horizontal pile movement due to lateral loads. LPILE software models soil behavior with p-y curves that are internally generated following published recommendations for nine standard types of soils. It also contains a feature that allows the user to manually introduce other p-y curves. There is a need to refine this program with soil data specific to typical soils found in Wisconsin. This entails developing site-specific p-y curves, based on known soil profiles and in-situ testing.

This study will provide both lateral and vertical movement information for foundation systems and analyze this data to better predict these values based on given inputs such as pile type and soil conditions.

III. SCOPE

There are several goals associated with this study. Both deep and shallow foundations will be investigated.

Work will involve providing a detailed literature review and summary of related research regarding past work associated with measurements/predictions of deep and shallow foundation movements, both horizontally and laterally. This will include gathering information on the use of LPILE and field methods used to develop and refine this software. A report will be presented at the conclusion of this work to the Project Oversight Team. (POT). This report will summarize the literature review and present a work plan for the remainder of the study. The POT and researcher will discuss/modify this plan to reflect Departmental needs.

Structure Movement: The researcher will develop a plan and conduct field testing to measure movement of shallow and deep foundations on a limited number (5-10 shallow and 5-10 deep) of projects. The Department will assist with the selection of these projects. The proposal should discuss project and soil types, as well as measurement methods and instrumentation. It may be necessary to obtain measurements throughout the construction cycle to address various movements as dead loads are being encumbered by the structure. Measurements should continue a certain amount of time past the end of construction. The researcher will summarize this field information and provide recommendations for a process to enable predictions of movement values based on foundation and soil types.

Lateral Pile Investigation: Work relating to LPILE will also require field data collection. WisDOT will provide soil boring information to the researcher at each of the field sites. Approximately 5-10 sites will be used for this portion of the study. The desire is to select individual sites that are of one uniform soil type. The Department will assist with the selection of these project sites. Pile test results from the Marquette Interchange and any other applicable WisDOT projects will also be provided to the researcher. It is anticipated that pressuremeter testing will be used, but the Department will consider other field test methods in addition to this testing. Field test results will be analyzed and compared to LPILE values. Correlations/refinements of LPILE will be presented. The researcher will also provide recommendations for typical lateral pile resistance loads based on pile type and subsurface soil conditions. They will further identify potential problems and limitations with the generation of this type of table.

Pertinent analytical analyses will be conducted as appropriate. Both full retaining and integral abutments should be considered. All data, findings, analyses and recommendations will be presented in a final report.

IV. SPECIFIC RESULTS, FINDINGS, TOOLS, ETC.

The researcher will be required to provide 40 printed copies of the final research report to be distributed to WisDOT (34) and WHP (6), as well as one electronic copy of the final version of the report. Data from this research will provide actual vertical and horizontal movements of shallow and deep foundations. Analyses of this data will be performed to enable predictions of horizontal and vertical foundation movements. This information can be used in future structural designs. Advantages and limitations of the data analyses will be provided. This research effort will also produce needed data and analyses to

correlate field measurements with LPILE to better simulate the behavior of Wisconsin soils. Results will allow development of a table of standardized lateral pile resistance values in relation to types of soil and piles. A final report documenting all research findings and conclusions, will be required.

V. LENGTH OF RESEARCH PROJECT AND APPROXIMATE COST

It is estimated that that the time required for this project should not exceed 36 months. The cost is estimated to be \$110,000. The project schedule should include a 3 month period for TOC review. As part of the researcher selection criteria, the TOC will evaluate the time and cost estimates in the submitted research proposals.

VI. URGENCY AND POTENTIAL BENEFITS

Results from this study will help the Department continue too move towards LRFD methodologies. They will also allow WisDOT to refine these methodologies to better reflect soils that are specific to Wisconsin. Performing a limited amount of field testing on some typical soils will allow the Department to gain knowledge on lateral pile movement properties and reduce the need to perform this testing on many transportation projects. This will result in savings in Geotechnical investigation costs that would be needed to establish these lateral load properties or the use of more conservative input values that may be more expensive than Wisconsin-specific values. It is hoped that results will allow development of a table of standardized lateral pile resistance loads in relation to types of soil and piles. Results will also enable WisDOT to make predictions of foundation movements based on foundation and soil types.

VII. ADDITIONAL REQUIREMENTS FOR IMPLEMENTATION

Results from this study will provide the Department with necessary information to better implement LRFD methodology by customizing it to local conditions, materials and test results. Results will also indicate current movements associated with differing foundations and soil conditions. Review of research results may lead to changes in Departmental practices. These changes may require revisions to the Bridge Manual, Construction and Materials Manual and/or the Facilities Development Manual. This work is beyond the scope of this research effort.